

Sustainability



Belle II

ErUM-FSP T09

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Bundesministerium
für Bildung
und Forschung



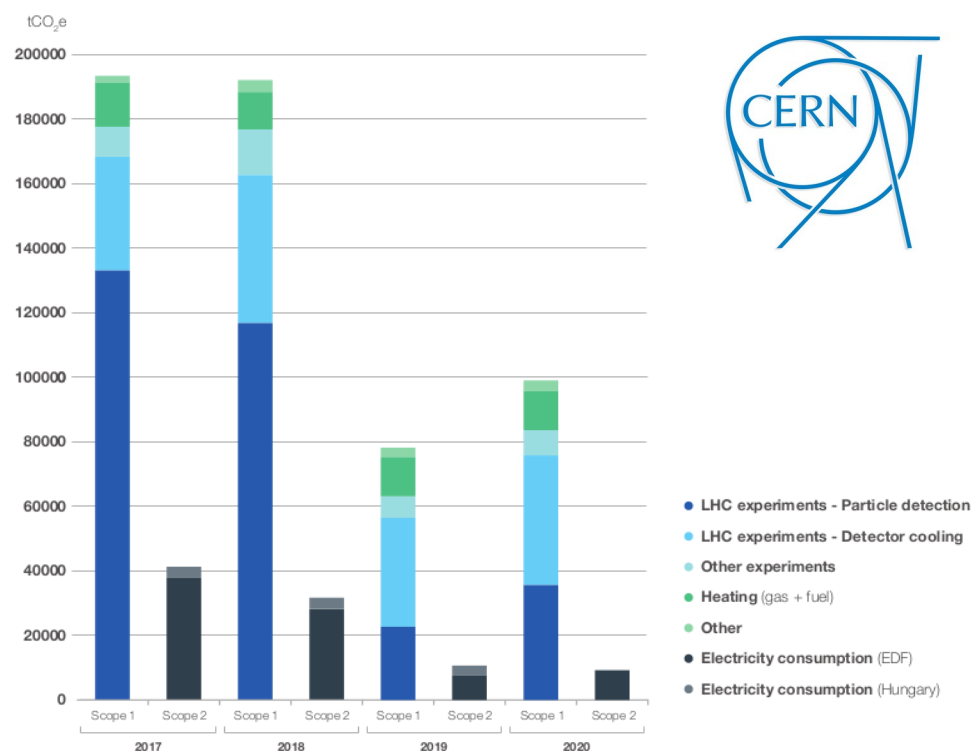
Sustainability @ Belle II

- Some information collected at <https://confluence.desy.de/display/BI/Sustainability>

Categories

- Accelerator
- Detector
- Computing
- Travel

➔ Unofficial, rough estimates on the following slides



CERN SCOPE 1 AND SCOPE 2 EMISSIONS FOR 2017-2020 BY CATEGORY.

Other includes air conditioning, electrical insulation, emergency generators and CERN vehicle fleet fuel consumption. Emission factors for electricity: EDF Bilan des émissions de GES 2002-2020 for EDF and Bilan Carbone® V8 for Hungary.

Accelerator

- No public numbers for SuperKEKB
- Electricity for KEK Tsukuba campus: 339 GWh in JFY2021

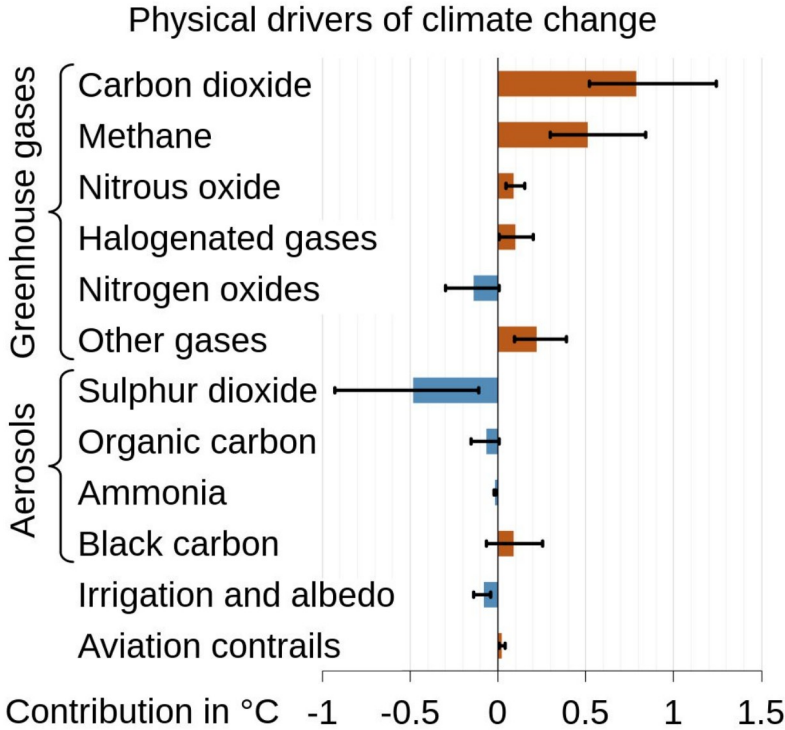
CO₂e estimate:

- Probably most of energy consumption for accelerator, here assuming half
- Conversion kgCO₂e per kWh for Japan: 0.4658
- ➔ ~80.000 tCO₂e

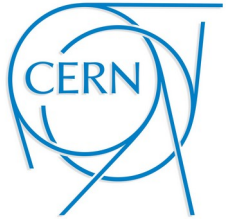
Detector

- Power consumption in JFY2022: 2.96 GWh → 1400 tCO₂e
- Information about gases collected by Caspar Schmitt

Global Warming Potential



Gas	Use	GWP
CO ₂	reference	1
CF ₄	wire chambers, gas electron multiplier	7390
C ₂ H ₂ F ₄	resistive plate chambers	1430
SF ₆	resistive plate chambers	22800

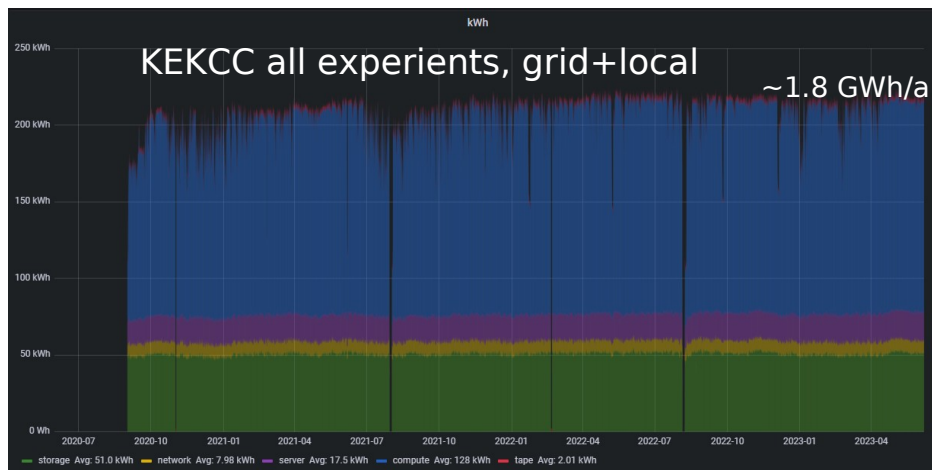


Gas	Use	GWP
He ₂	50% CDC	0
C ₂ H ₆ (ethane)	50% CDC	8
N ₂	cryogenics	0, but forms N ₂ O with 298



Computing

- Information collected by Lorenz Gärtner and David Koch
- Detailed accounting of grid computing resources by CSG
- Assumed conversion: 500 W / kHS06 → ~1 GWh per year (ATLAS+CMS: ~35 GWh/a)
- Assuming 0.4 kgCO₂e / kWh → ~400 tCO₂e per year



storage, network, server, compute, tape

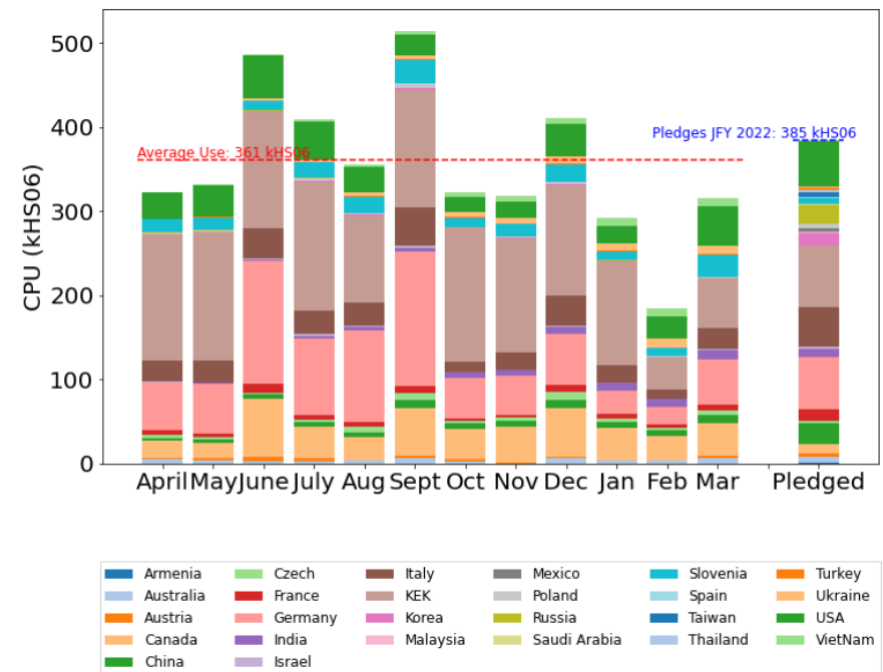


Figure 1: CPU power per month (in kHEPspec06) used in different countries during 2022, including both grid and local resource usage.

Travel



45th B2GM flight emission estimate

- 209 participants
- 56 participants were assumed to not take a plane due to being located in Japan
- the location and therefore emissions of 8 participants could not be determined
- the other 145 participants spent **313 t CO₂e** flying to NGO (~2.2t per person)
- this is an underestimate because direct flights were assumed.

Summary for Belle II

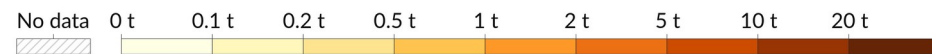
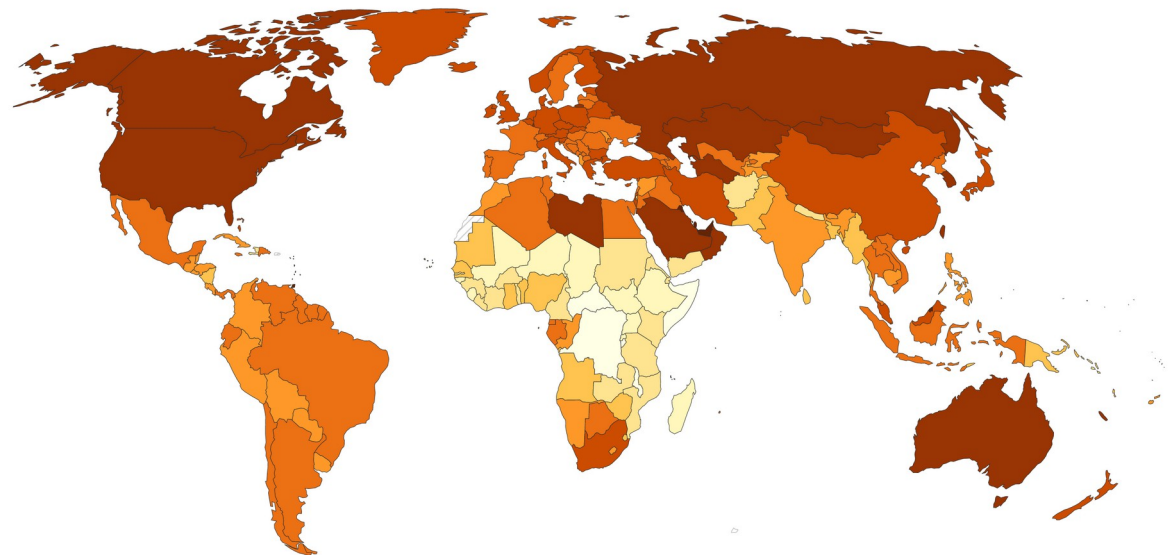
- Accelerator: $O(100.000)$ tCO₂e per year
- Detector, Computing, Travel: each $O(1000)$ tCO₂e per year

➔ ~ 100 tCO₂e/a
per member

Per capita CO₂ emissions, 2021

Carbon dioxide (CO₂) emissions from fossil fuels and industry¹. Land use change is not included.

Our World
in Data



Source: Global Carbon Budget (2022); Gapminder (2022); UN (2022); HYDE (2017); Gapminder (Systema Globalis)
OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY

Institute / Group Level

AG-Kuhr flight emissions

September 2022 — August 2023: **14.8 t CO₂e**



Personal Level

- <https://www.carbonfootprint.com/calculator.aspx>

Rough estimates for one year:

- Flights (1 to Japan, 1 to US): 6.1 tCO₂e
- Secondary: 4.3 tCO₂e (2.0 for food)
- Home (electricity, w/o heating): 1.2 tCO₂e
- Car: 0.8 tCO₂e
- Public transport: 0.1 tCO₂e

Do We Want To Do Something?

- Many (good or not so good) reasons not to act

The Four Problems

(Keystone-SDA) "Die vier grössten Umweltprobleme sind: Der Mensch ist dumm, faul, egoistisch und kurzsichtig", sagte der Professor für Klimaphysik an der ETH Zürich Reto Knutti im Interview mit der "SonntagsZeitung". Der Klimawandel-Stopp sei eine gesellschafts-politische Frage.



<https://www.swissinfo.ch/ger/alle-news-in-kuerze/klimaphysiker---mensch-ist-dumm--faul--egoistisch-und-kurzichtig-/48016602>

What Can We Do?

- Raise awareness
- Improve transparency
(CO₂e of jobs, sites, publications, theses, ...)
- Ask KEK about its plan to become CO₂ neutral
- Reduce (air) travel: fewer but longer trips (e.g. for shifts), optimize location of meetings
- Promote reuse/sharing of (ntuple) data samples
- Improve code efficiency
- Early detection of issues to not waste resources
- Default vegan food option
- [Your ideas here ...]